ABSTRACT
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MEMS fluidics

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Recent breakthroughs in sacrificial surface micromachining (SSM) led to development of the surface micromachined microfluidic devices. A fundamental “building block” of microfluidic devices is a microfluidic channel (microchannel). A typical surface micromachined microchannel is about 2 µm deep, its width and depth depend on the specific application, while its top is less than 1 µm thick (and typically consists of) silicon nitride membrane. Almost all microfluidic devices are concerned with flow through very small passages where unintentional restrictions lead to high-pressure gradients within the microchannels, which, in turn, cause deformations of the membranes. Knowledge of these deformations facilitates design and optimization of the microfluidic devices. We have developed a hybrid approach for accurate and precise characterization of microfluidic devices. This approach is based on analytical, computational, and experimental solutions (ACES) methodology. The experimental aspects of this methodology are based on laser interferometric measurements yielding displacement/deformation fields, while analytical and computational aspects are based on exact (closed form) and approximate (FEM) solutions, respectively. Comparison of analytical, computational, and experimental results indicates correlation to within 1%, for maximum deformations on the order of 1 µm. Continued advances in the methodology for characterization of microfluidic devices will lead to development of robust devices, which will allow their integration with electronic actuation to enable a broad range of revolutionary new applications achievable with SSM.

Keywords: MEMS, microfluidics, sacrificial surface micromachining, microchannel, ACES methodology, laser interferometry, optoelectronic laser interferometric microscope.